THE IMPACT OF TRAFFIC CALMING DEVICES ON EMERGENCY FIRE RESPONSE

Executive Analysis of Fire Service Operations in Emergency Management

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ABSTRACT

This research project employed evaluative research to determine the impact that traffic calming devices have on emergency fire department response in the City of Bellevue, Washington. Evaluative research methods were employed to (a) determine what traffic calming devices are and the scope of the problem in Bellevue, (b) determine whether traffic calming devices negatively impact fire department response, (c) determine the cumulative impact of traffic calming devices on emergency response, (d) determine possible emergency response mitigation measures for traffic calming devices.

The major findings of the research suggest that some types of traffic calming devices are likely to negatively impact the travel time component of emergency fire response. In addition, the cumulative impact of various devices can represent significant delays. Measures to mitigate the impact of traffic calming were identified and procedures to implement policies were suggested. Suggested mitigation measures included the development of a emergency response route map, designation of appropriate levels of traffic calming measures based upon traffic volume and emergency response priority, and the development of a memorandum of understanding between the Department of Transportation and the Fire Department.

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INTRODUCTION

The Bellevue, Washington Fire Department, like many fire service providers, has historically used response time as a key service delivery performance measure. Generally, a lower emergency response time correlates into improved incident outcomes. More recently, efforts in Bellevue to install physical devices to slow traffic and improve neighborhood livability has been on the increase. These devices, including speed humps, traffic circles, curb extensions, and medians serve as impediments to efficient fire department emergency response. The installation of these devices on neighborhood streets represent a significant problem to the fire department and poses a distinct threat to the efficiency of the fire protection delivery system of the community.

The purpose of this research project is to identify the impact that traffic calming devices have on emergency fire department response in Bellevue, Washington. In order to ascertain the scope of the problem, an evaluative research project was conducted to answer four key questions:

1. What are traffic calming devices and how pervasive are they in the community?
2. Do traffic calming devices adversely impact fire department emergency response capability and, if so, to what degree?
3. What is the cumulative effect of multiple traffic calming devices?
4. What mitigation measures can be employed by the City of Bellevue to reduce or eliminate the impact of traffic calming devices?

As a result of this study, various improvement strategies were identified which, when implemented, are designed to mitigate the impact that physical traffic calming devices have on fire department emergency response.

BACKGROUND AND SIGNIFICANCE

The Bellevue Fire Department, like many fire service providers, has historically used response time as a key service delivery performance measure. Generally, a lower emergency response time correlates into an improved incident outcome and Bellevue Fire has jealously protected against any activities which might negatively affect travel time. More recently, Bellevue Fire Department, like many fire departments throughout the country, has faced mounting pressure to allow various types of traffic speed reduction measures as part of an increased emphasis on neighborhood livability and safety.

The City of Bellevue, long referred to as a “bedroom community” of Seattle, has burgeoned into a commerce center and hub of a rapidly growing global technology industry. With the growing population, transportation impacts have become a major concern in the community. A lack of adequate arterial streets has resulted in traffic migrating to previously quiet residential streets and has resulted in vehicle speeds considerably faster than the 25 mile per hour posted limit. Residents, seeking to improve neighborhood safety and the general quality of life, have sought relief through the implementation of various physical measures, known in the transportation industry as traffic calming devices.

Traffic calming devices refer to a group of devices placed in and along roadways for the purpose of slowing traffic and increasing pedestrian safety. These devices include, but

are not limited to, speed humps, traffic circles, curb extensions, rumble strips, edge lines, and pedestrian refuge islands (Gutshick, 1998). Traffic calming are, by their very nature, designed to indiscriminately slow traffic, including fire apparatus. As the traffic conditions in the community worsened, the fire department became increasingly concerned about the growing community acceptance and reliance of physical devices as a solution.

The fire department has closely monitored response times and considers the travel time component of response time a critical function. The fire department has set department performance measure of six minutes or less for fire response and four minutes or less for emergency medical response. The anatomy of a typical response time in Bellevue suggests that over 70% of the response time to an emergency incident is the result of drive time. The Fire Department believes that significant degradation in travel time will impact the fire departments ability to meet the performance measures. In 1997, the department fell considerably short of the stated response time for emergency medical calls, meeting the four minute target a mere 22% of the time.

The National Fire Academy course, “Executive Analysis of Fire Service Operations in Emergency Management”, clearly identifies the fire department delivery system as a key component of a comprehensive risk analysis system.

LITERATURE REVIEW

The desire of city residents to seek refuge from the problems of urbanization is changing the face of neighborhoods (Railey, 1996) Citizens living in urban communities want to live in neighborhoods that provide security, peace and quiet, comfort and

cleanliness. They simply want to provide a safer, more livable environment for their families.

The City of Portland, Oregon has defined livability as encompassing the following characteristics (Atkins, 1998):

- The ability of residents to feel safe and secure in their neighborhood.
- The opportunity to interact socially with neighbors without distractions or threats.
- The ability to experience a sense of home and privacy.
- A sense of community and neighborhood identity.
- A balanced relationship between the multiple uses and needs of a neighborhood.

One of the most significant element of neighborhood livability is traffic. In his book *Defensible Space*, Oscar Newman (Newman, 1972) believes that a constant and increasing flow of unwanted traffic reduces contact between neighbors; increases crime (especially crimes of opportunity, such as burglary); decreases the amount of investment people will make in their homes, and therefore the neighborhood; and decreases housing values.

Efforts to combat this decline in the quality of life has increasingly used neighborhood traffic management programs which include traffic calming devices. Traffic calming and traffic management have been defined in several ways, but they generally are considered to be any number of initiatives which have been undertaken in order to reduce the negative impact of vehicular traffic (Railey, pg 11). Hoyle, defines traffic calming as a holistic, integrated traffic planning approach that seeks to equalize the use of streets between automobiles, pedestrians, bicyclists, and playing children (Hoyle, 1995) These

programs are designed to improve the livability of a neighborhood by responding to traffic issues related to speeding, congestion, excessive volumes of cut-through traffic, and accidents.

Neighborhood traffic management is generally achieved through the construction of physical barriers such as cul-de-sacs or the use of full or partial traffic diverters, including speed humps, traffic circles, and brick or metal gates.

Passive traffic control devices include traffic signs and signals, brush trims, textured pavements, markings at pedestrian crosswalks, educational programs, and traffic enforcement. These devices are meant to improve safety and reduce accidents by making drivers more aware of their actions (McGinnis,1997).

Active traffic control devices include speed humps, traffic circles, cul-de-sacs, chokers or curb extensions, gates across roadways, medians,

The installation of traffic calming devices in many communities is often focused on the installation of one or two types of specific devices with little or no area-wide planning (Railey, pg. 23). Generally, a neighborhood group complains and a device is installed where requested and little follow-up is conducted.

Literature seems to suggest that initiatives which are broader in scope, using more than one strategy, with a variety of devices are more appropriate. The City of Bellevue, Washington, utilizes a two-phased program with each phase containing specific techniques for addressing traffic concerns in the neighborhood. Phase I or the first year of response involves educational, passive and less restrictive measures and phase II or second year involves more physical measures (Gonzales, 1993).

Unfortunately, devices which reduce overall vehicular speeds also impact emergency response vehicles by increasing their response times. Of particular significance is the cumulative impact that these devices can have on fire department emergency response. Ironically, the fire service, a primary provider of public safety, is faced with a difficult dilemma - opposing these devices because they adversely affect fire-rescue service delivery, or tolerating the devices since they prevent accidents and injuries to the public (Gutschick, 1998)

PROCEDURES

The growth of the City of Bellevue and the surrounding Seattle metropolitan area has resulted in significant traffic problems. In fact, many studies of national significance rank the Seattle metropolitan area traffic as some of the worst in the nation. Over the past several years, the City, through it's transportation department, has placed a strong emphasis responding to neighborhood concerns over traffic speeding and volume. The Bellevue Transportation currently maintains a Neighborhood Traffic Control Program (NTCP) as a separate and distinct division.

Since 1996, the NTCP had seen a dramatic increase in the number and quantity of neighborhood request for physical traffic calming devices as a solution to local traffic problems (figure 1).

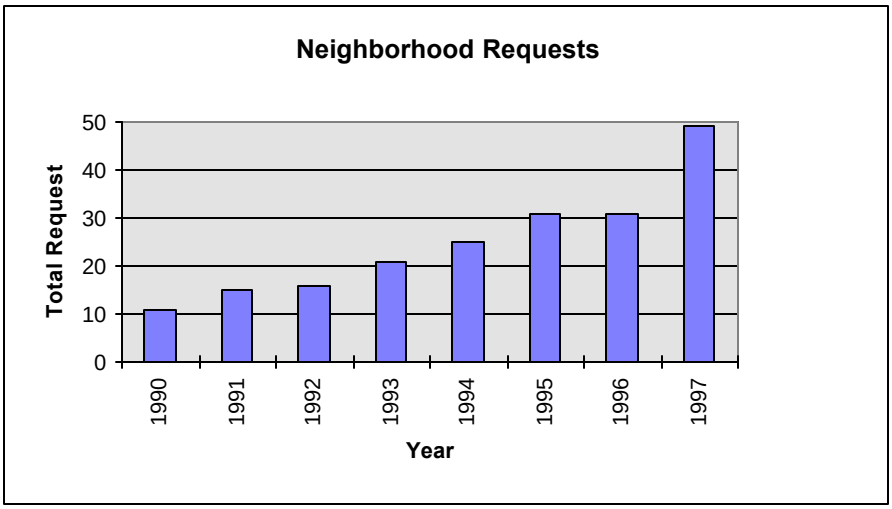

Figure 1

The desired outcome of this research was to evaluate whether the use of physical traffic calming devices created a negative impact on fire department emergency response. The research was evaluative in nature since the impact of various types of traffic calming devices were measured and analyzed in comparison to a route of travel void of physical barriers. In addition, research was conducted to determine whether limitations could be placed on the application of physical devices specific to fire department emergency response needs.

To determine the scope of the issue, contact was made with the staff of the Bellevue NTCP. This transportation department division includes 2.5 full time employees who monitor neighborhood requests and develop strategies to respond to complaints. Although the NTCP was aware of the general fire department concerns about emergency response,

they believed that a lack of fire department focus on the problem to date represented a tacit approval of the program. In cooperation with the NTCP, it was determined that a comprehensive review of the impact that physical devices had on emergency response should be undertaken and attempts made to mitigate any fire department concerns by limiting the application of physical devices to specific locations.

A committee was appointed with representatives of the Fire, Police and Transportation department. The mission of the group was to investigate the impact that traffic calming had on emergency response and develop a comprehensive policy that could be used to advise neighborhood groups about the impact that traffic calming efforts might have on public safety. The group met on a regular basis for approximately six months and developed the following:

- A comprehensive transportation map which identifies key emergency response routes.
- A hierarchy of traffic calming solutions which reserved the more restrictive devices to those streets or locations which represented less impact to fire emergency response
- The development of a memorandum of understanding between the transportation and the fire department which outlines the responsibilities of each agency.

The identification of the emergency response routes was based upon the input of apparatus drivers from the nine Bellevue fire stations, along with a review and approval of the Fire Administration. The routes were selected based upon their current use by fire companies and the access they provided to existing neighborhoods. Traffic volumes on

these routes were calculated by transportation department engineers and negotiations ensued between the various members of the committee as to the relative priority of each route.

Once the decision was made on which streets were to be designated as emergency response routes, each route was analyzed based upon traffic volumes and the relative importance as a fire department emergency route. A category and color scheme was developed which labeled each street which correlated to a specific menu of devices which could be placed on the street (Exhibit A).

The final aspect of the project was to identify the various interests and objectives of both the Fire and Transportation Departments and to meld those into a Memorandum Of Understanding. This document included three basic sections, including a general policy description, purpose and policy statements. The two affected departments met and negotiated a final document which was signed by both the Fire Chief and the Acting Transportation Director (Exhibit B).

Results

Answers to Research Questions

Research Question 1. *What are traffic calming devices and how pervasive are they in the community?*

The definition of traffic calming devices has been a confusing subject, even for the transportation industry. In fact, the International Traffic Engineers appointed a subcommittee in 1996 to develop a common definition which could be used by transportation professionals, as well as political leaders, to communicate the concept to their community (Lockwood, 1997). This committee developed the following definition:

"Traffic calming is the combination of mainly physical measures that reduce the of motor vehicle use, alter driver behavior and improve conditions for non-motorized street users. "

The City of Bellevue believes that traffic calming is a based upon a much broader perspective of traffic management and has incorporated three important elements into it's Neighborhood Traffic Control Program (NTCP); education, enforcement and engineering. The City has developed a two-year, two-phase program, with each phase containing specific techniques for addressing traffic concerns. The first year or Phase I, involves educational, passive and less restrictive measures. Phase II, or the second year, involves physical measures. The Fire Department was particularly concerned with the Phase II projects and focused most efforts in this portion of the program.

The installation of devices as been on-going since 1985. A review was undertaken to determine the number and location of devices currently within the City of Bellevue. The results of that research indicated that numerous devices were installed within Bellevue in a wide variety of locations (Exhibit C). The locations were varied throughout the City and included devices in all quadrants. The physical device inventory included:

- Speed Humps
- Curb Extension
- Median
- Full Closure
- Partial Closure

- Entry Treatment
- Circle
- On Lane Zone

Research Question 2. *Do traffic calming devices adversely impact fire department emergency response capability and, if so, to what degree?*

There is essentially no quarrel with the fact that physical traffic calming devices do, in fact, cause emergency response delays. The question is what impact these devices have and how significant is it. In order to determine the amount of delay which could be expected by each type of device, various tests were conducted. These tests included driving over and through existing physical devices and measuring by stopwatch and radar the resultant reduction in speed. These numbers were then correlated against known studies in the field to determine reliability. The Bellevue test results correlated closely to studies conducted in both Portland, Oregon (Atkins, 1998) and Montgomery County, Maryland (Gutschick, 1998). As a result, tables were constructed providing probable impacts for both speed humps and traffic circles (Exhibits D,E,F).

The faster the speed and the larger the vehicle, the most significant the delay. For example, an aerial truck with a desired response speed of 40 miles-per-hour, experienced a travel time delay of 9.2 seconds when encountering a traffic circle. In addition, the impact distance, or the length of street where a given vehicle cannot be driven at the desired speed because of the traffic circle influence, was found to be approximately 1255 feet.

Question 3. *What is the cumulative effect of multiple traffic calming devices?*

The cumulative impact of traffic calming devices is probably the most significant with respect to fire department concerns. Although a single device represents a response delay which can be measured in seconds, multiple devices can extend the delay considerably. For example, if a fire apparatus responding to an emergency scene encounters three speed humps and two traffic circles, the resultant delay, based upon the research suggested above, could add an additional 30-60 seconds to the travel time portion of the emergency response. A far greater impact could occur for a secondary piece of equipment which may be responding as back-up, or, in the case of simultaneous alarms, could be the first arriving fire department resource. If you consider that this responding company may need to negotiate through a set of traffic calming devices located within their own response area, and then negotiate a second set of devices in the neighborhood of the incident, the delay could extend into minutes, rather than seconds. The impact of cumulative devices currently located within Bellevue is dependent on the number and type of device. However, the ability to assign a numerical delay per device is critically important in the long term strategy of the more important cumulative impact.

Question 4. *What mitigation measures can be employed by the City of Bellevue to reduce the impact of traffic calming devices?*

The fire and transportation department committee on traffic calming met on a regular basis throughout 1998 to develop a plan of action to identify measures to reduce the impact of traffic calming on fire department operations. The efforts of the committee culminated in December, 1998 with a presentation made to the City Council regarding traffic calming, emergency response, and neighborhood transportation issues. As a result of the efforts of the committee, a Memorandum of Understanding was developed between the City

Transportation and Fire Departments which identified various measures which could be undertaken to deal with traffic calming.

Emergency routes were identified and placed on a map. These routes took into account the frequency of emergency response, the area served by a specific route, and any historical or institutional knowledge which resulted in the use of a specific street . These routes were then plotted onto a map (Exhibit A) and reviewed by the committee and the Fire Chief. Each route was assigned a category and color coded designator based upon existing traffic volumes and priority as an emergency response route. The designators were designed to provide specific recommendations as to what type of traffic calming could be included on a street. The four types of streets were:

Traffic Calming Street Designator Matrix
Table 1

	Category I	**Category II**	**Category III**	**Category IV**
Map Color	Black	Green	Purple	Red
Speed Humps 12' Design	yes	no	no	no
Speed Humps 22' Flat Top	no	yes	no	no
Traffic Circles	yes	no	no	no
Curb Extensions	yes	yes	yes	no
Medians	yes	yes	yes	no
Entry Treatments	yes	yes	yes	no
Slow Points	yes	no	no	no
Chicanes	yes	no	no	no
Partial Closures	yes	no	no	no
Full Closures	yes	no	no	no

A Memorandum of Understanding was created which committed to paper the positions and recommendations of both the Transportation and Fire Departments (Exhibit

B). This document was signed by both directors and incorporated as the policy of each organization. A general policy description was included which stated the philosophy of the City relating to traffic calming. It stated:

> "The City receives numerous citizen requests each year to reduce vehicle speeds and/or non-local traffic in neighborhoods. To address these issues, the City works with neighborhoods as part of the City's Neighborhood Traffic Calming Program. Although education and less restrictive measures are the preferred approaches to calming traffic, experience has shown that on some streets, the use of physical devices might be more appropriate. Experience has also shown the use of physical devices has a negative impact in delaying response time for emergency services, especially if there are several devices that have a cumulative impact on primary fire response routes."

In addition to an overall policy statement, a purpose statement and various specific policies were stated which identify the process the City would follow when dealing with neighborhood requests for traffic calming. These policies resulted in direct involvement by the Fire Department for any decision making leading to the installation of physical devices.

DISCUSSION

The results of the study were clearly consistent with the specific findings discussed in the literature review portion of this report. In fact, after conducting preliminary traffic calming response delay testing with City of Bellevue transportation officials, it was discovered that the results were very close to those conducted by both the City of Portland,

Oregon (Atkins, 1998) and Montgomery County, Maryland (Gutschick, 1998). Railey, (pg 29) quite clearly identifies fire department concerns regarding traffic control devices when she suggests,

> "Traffic control devices pose many problems for emergency response agencies. They block the paths and hinder the mobility of emergency apparatus. They can cause trauma to patients being transported to the hospital. They can cause damage to vehicles. They may affect how fire departments respond to calls. They may interfere with firefighting operations on the scene. Traffic control devices may even affect how the locations of new stations are determined."

These are essentially the same issues identified in this report and the rationale utilized in the development of the policy and procedures to be used for traffic calming by the Bellevue Fire Department. There appears to be no question that fire officials are likely to be at odds with transportation engineers and neighborhood advocates when it comes to the installation of traffic calming physical devices.

The study results suggest that a cooperative partnership can be forged between those concerned with emergency response and others concerned about neighborhood livability. The two issues do not necessarily need to be mutually exclusive. A concept which needs to be understood by all parties is the issue of cumulative impact of various types of devices. A single device, on the surface, does not appear to represent a significant issue for the fire department. However, when presented as a series of delays caused by multiple devices, a potentially serious delay consequence emerges.

The organizational implication to the Bellevue Fire Department is rather significant. Workload issues are affected in that a review and approval process has been incorporated which will require additional staff resources. However, some of this workload will likely be mitigated by the ability to follow the written policies and procedures outlined in the memorandum of understanding. The study will result in a much greater appreciation by the community of the impact that the installation of traffic calming devices have on emergency fire department response.

RECOMMENDATIONS

The information that was gathered during the development of this study has provided an excellent foundation for the incorporation of emergency response concerns into any traffic management program. The Memorandum of Understanding provides appropriate and logical policies and procedures and should be implemented to ensure that fire department concerns are considered and incorporated into any traffic management plan.

The Fire Department should continue to evaluate the effectiveness of the Memorandum of Understanding and a thorough review should be undertaken after one year to measure the impact of the conditions expressed within the MOU.

The Fire Department should fully participate in neighborhood meetings as a partner of the transportation department and provide information and testimony regarding the impact or consequences of traffic calming measures on emergency fire department response. Many of the projects currently brought forward for consideration by neighborhood groups originate through the neighborhood enhancement program. This program provides funds for various neighborhood improvement projects and fire department representatives should utilize this forum to educate citizens regarding the impact of physical traffic calming devices.

REFERENCE LIST

Atkins, Crystal, et.al. (1998, March), *The Influence of Traffic Calming on Emergency Response Times*, ITE Journal.

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Hoyle, Cynthia L. (1995*), Traffic Calming: Planning Advisory Service Report Number 456*, American Planning Association.

Lockwood, Ian M. (1997, July), *ITE Traffic Calming Definition*, ITE Journal.

McGinnis, Lindy (1997, January), *Things That Go Bump In The Night*, NFPA Journal.

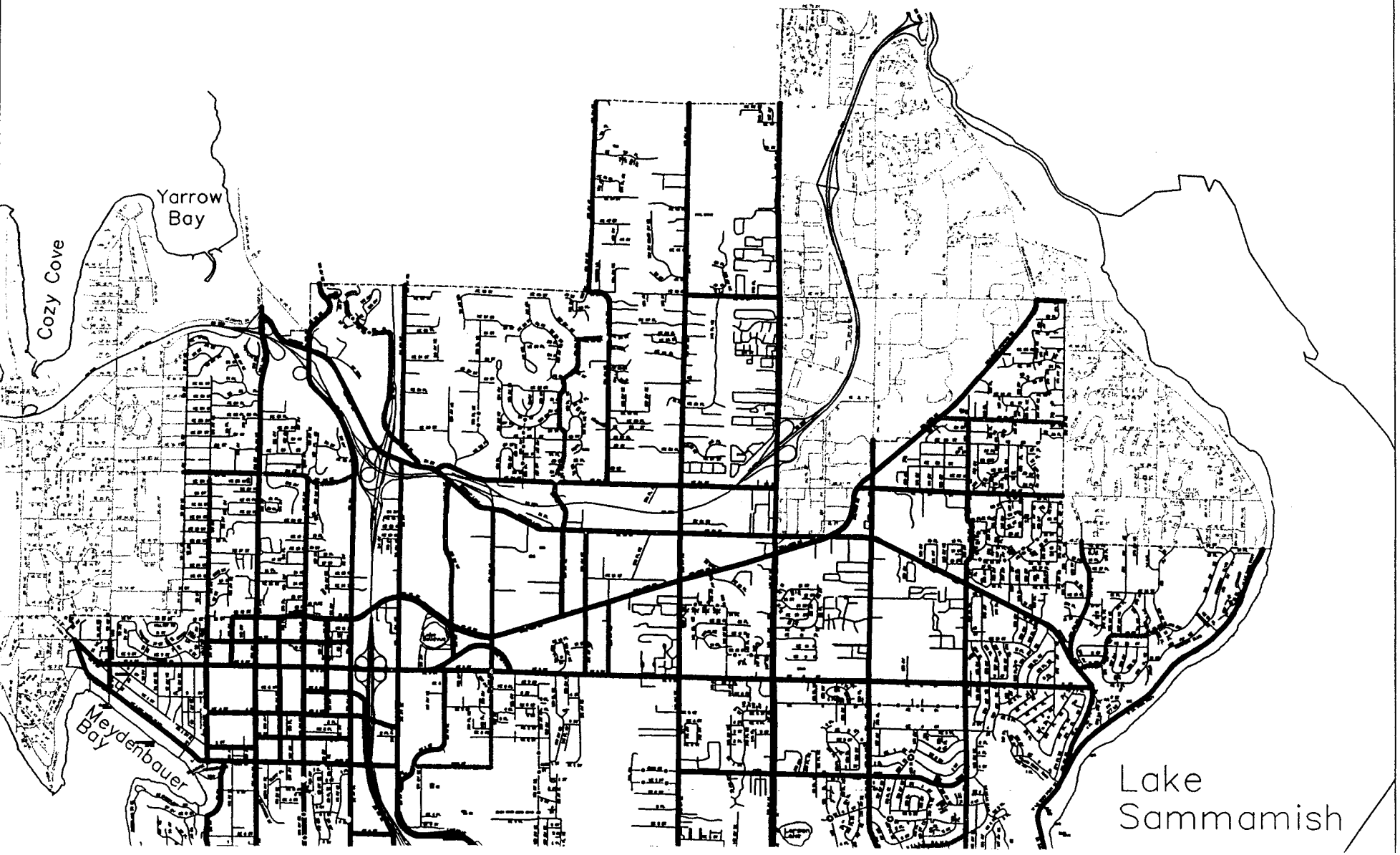
Newman, Oscar (1972), *Defensible Space*, The MacMillan Company.

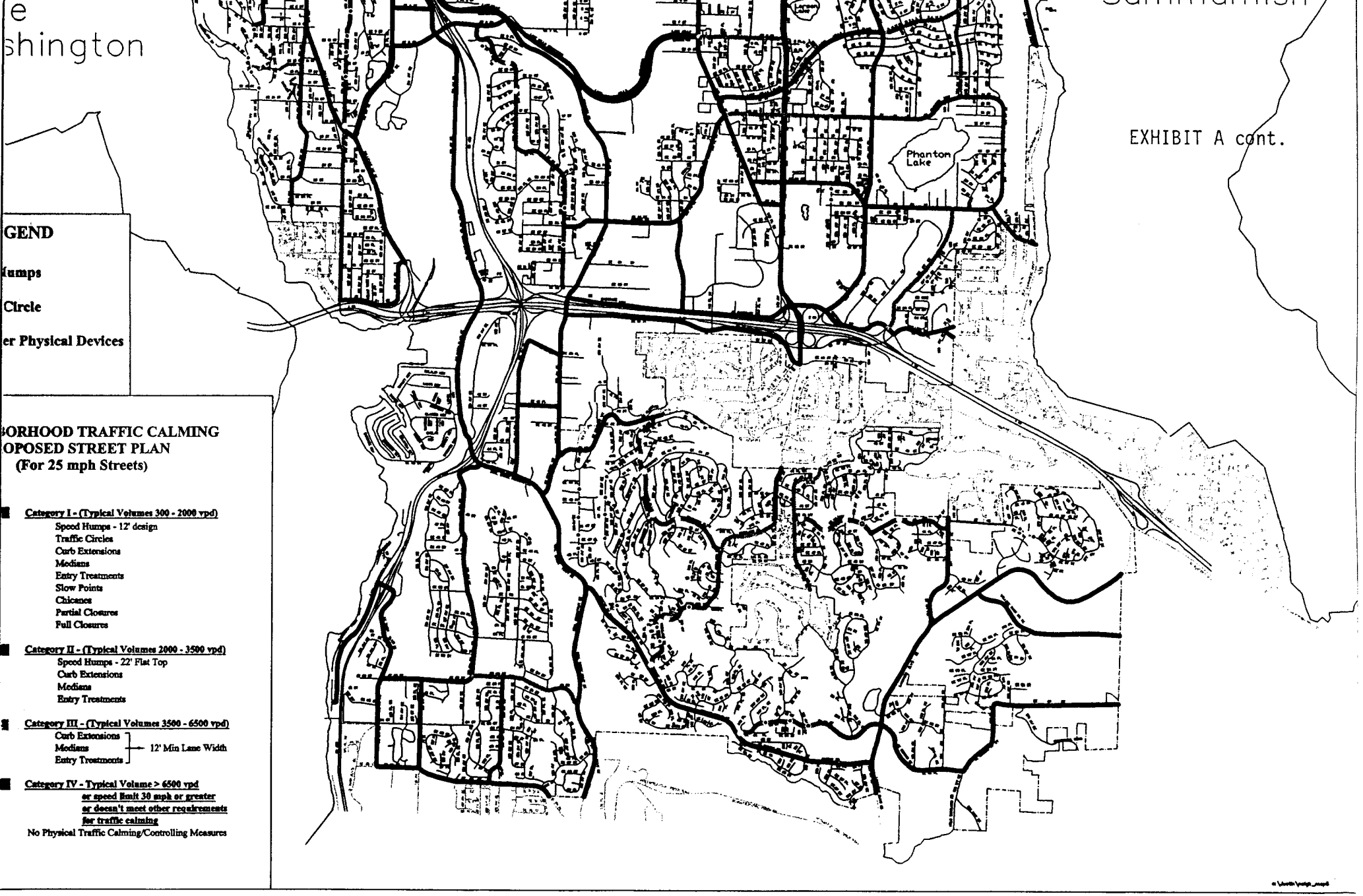
Railey, Melinda (1996, May), *The Impact of Traffic Management Programs On The Delivery of Fire Suppression and Emergency Medical Services*, University of Texas.

EXHIBIT A

CITY OF BELLEVUE

NEIGHBORHOOD TRAFFIC CALMING
TRAFFIC OPERATIONS PROPOSED STREET PLAN

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shington
Sammamish
Phanton Lake
EXHIBIT A cont.
GEND
lumps
Circle
er Physical Devices
ORHOOD TRAFFIC CALMING
OPOSED STREET PLAN
(For 25 mph Streets)
Category I - (Typical Volumes 300 - 2000 vpd)
Speed Humps - 12' design
Traffic Circles
Curb Extensions
Medians
Entry Treatments
Slow Points
Chicanes
Partial Closures
Full Closures
Category II - (Typical Volumes 2000 - 3500 vpd)
Speed Humps - 22' Flat Top
Curb Extensions
Medians
Entry Treatments
Category III - (Typical Volumes 3500 - 6500 vpd)
Curb Extensions
Medians
Entry Treatments
12' Min Lane Width
Category IV - Typical Volume > 6500 vpd
or speed limit 30 mph or greater
or doesn't meet other requirements
for traffic calming
No Physical Traffic Calming/Controlling Measures

EXHIBIT B

City of Bellevue
Fire Department/Transportation Department

Memorandum of Understanding:
The Use of Traffic Calming Devices

Effective: October 1, 1998

1.0 General Policy Description

The City receives numerous citizen requests each year to reduce vehicle speeds and/or non-local traffic in neighborhoods. To address these issues, the City works with neighborhoods as part of the City's Neighborhood Traffic Calming Program. Although education and less-restrictive measures are the preferred approaches to calming traffic, experience has shown that on some streets, the use of physical devices might be more appropriate. Experience has also shown the use of physical devices has a negative impact in delaying response time for emergency services, especially if there are several devices that have a cumulative impact on primary fire response routes.

2.0 Purpose

The purpose of this MOU is to provide an understanding between the Fire Department and Transportation Department, identify streets throughout the City of Bellevue which are used as primary emergency response routes, and identify a process to include the Fire Department in the review of Neighborhood Traffic Calming projects. It is recognized that the use of physical devices to control vehicle traffic is desired by many Bellevue neighborhoods to protect and preserve the quality of life in those neighborhoods, and that a reasonable approach will be taken in the development and implementation of neighborhood traffic calming plans.

3.0 Policy

3.1 All traffic calming projects will be reviewed by the Fire Chief or his or her designee prior to installation. Every effort shall be made to include the Fire Department in the development and design process from the earliest stages of design concept.

3.2 The Neighborhood Street Plan map (developed between the Fire and Transportation Departments), will be used as a guide to determine the type of device that would be acceptable for a particular street segment. In addition, guidelines regarding vehicle speeds, adjacent land-uses and area topography will be taken into consideration.

3.3 The Departments recognize that some traffic calming projects may cause a "cumulative impact" on fire response. Cumulative impact is defined as: ***"the potential negative impacts on emergency response time and route patterns by projects on***

two or more adjacent fire response routes." When these situations occur, the Departments will estimate the amount of potential delay (based on vehicle delay calculations - see attached chart/specifications), and determine if the delay is at an acceptable level. If unacceptable (based on the performance measures of the Fire Department), the traffic plan will be modified with less restrictive physical measures.

3.4 A Fire Department representative will attend neighborhood traffic meetings to discuss the effects of physical devices. Should the Fire Department be unavailable to attend the meeting, a flyer will be distributed on "Emergency Response Delay" by Transportation Department staff. The flyer will be prepared by the fire Department and will note the implications of physical devices on emergency response times. The flyer must state "We realize the importance of residents understanding that physical devices like speed humps and traffic circles cause delays for responding and transporting emergency apparatus, which may adversely impact the outcome of certain life-threatening incidents. Those in favor of these devices must be willing to accept the likely probability of slower fire-rescue service delivery, and evacuation problems in their community and neighborhoods."

3.5 Should the community accept the delay, the project will move forward to design and construction.

3.6 Before final design, the Fire Department will be invited to participate with Transportation Department staff in a "field review" of the location. During this time, the device will be painted on the pavement and cones used to verify turning radius, etc. of fire apparatus. Modifications will be made to the plan as necessary to accommodate these vehicles.

3.7 Once the plan is constructed, the Transportation Department will evaluate the effectiveness of the project and share its findings with the fire Department. At that time, modification and/or removal may take place depending on the effectiveness of the plan in meeting the community's needs.

Approved this 7 day of DECEMBER, 1998.

Fire Chief Pete Lucarelli

Nora Johnson
Acting Transportation Director

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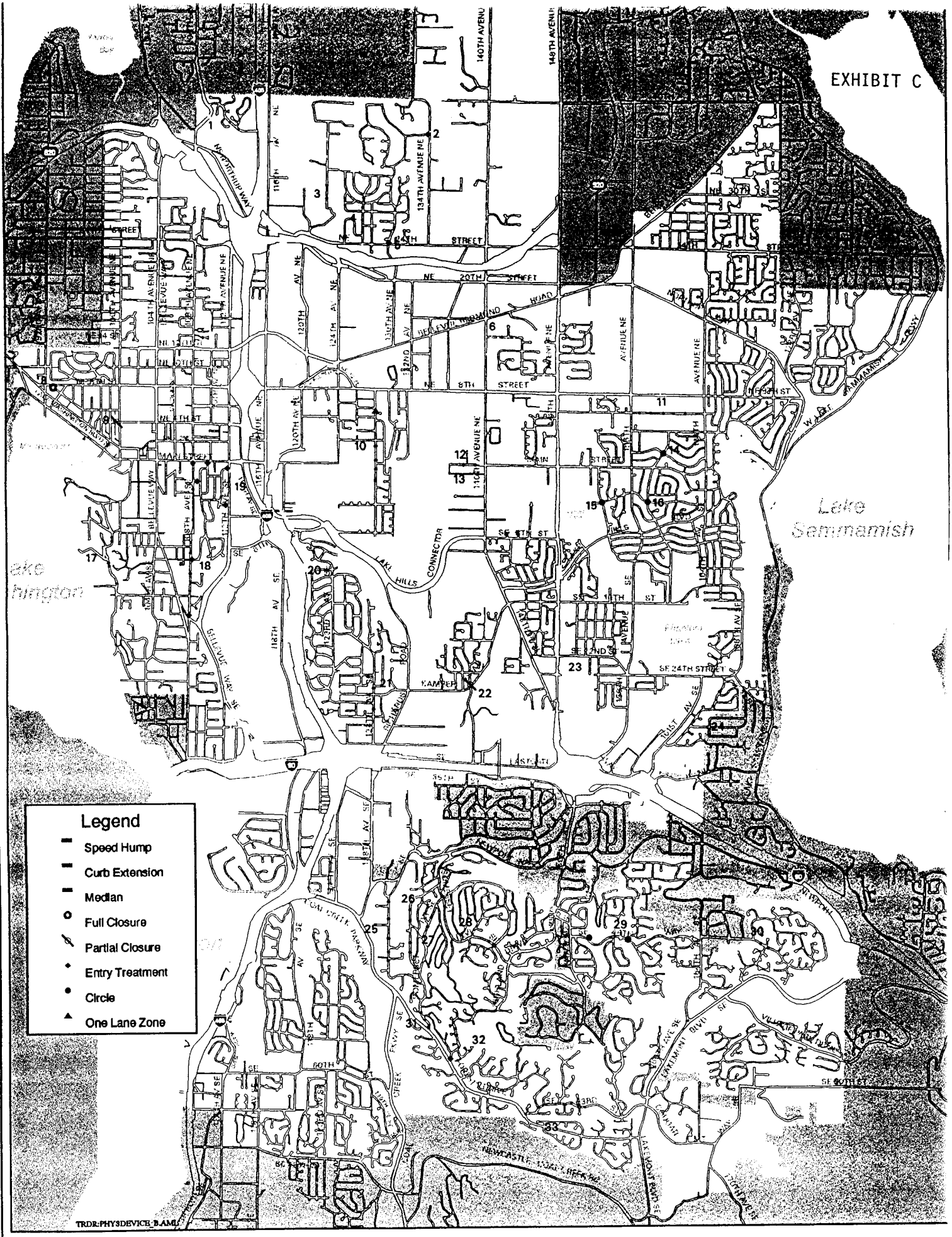
12/3/98

EXHIBIT C



SCALE 1:38400

= 3200 feet

1" on the map represents 3200' on the ground.

Typical Impacts of Traffic Circles on Emergency Vehicles

VEHICLE	LOWEST SPEED (MPH)	DESIRABLE SPEED (MPH)	TRAVEL TIME DELAY (SECONDS)	IMPACT DISTANCE (FEET)
Fire Engine	14	25	2.8	261
	14	30	4.3	489
	14	35	6.1	671
	14	40	8.5	814
Aid/Medic	16	25	1.3	170
	16	30	2.3	301
	16	35	3.1	467
	16	40	5.1	612
Aerial Truck	11	25	3.9	338
	11	30	5.2	555
	11	35	7.3	845
	11	40	9.2	1255

Lowest Speed: This is the lowest speed a vehicle travels when navigating around a traffic circle.
Desirable Speed: This is the speed a driver might wish to travel if there were no traffic circles.
Travel Time Delay: This is the additional time required to travel to a destination due to a traffic circle's influence.
Impact Distance: This is the length of street where a given vehicle cannot be driven at the desired speed because of the traffic circle's influence.

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Typical Impacts of 22-Foot Speed Bumps on Emergency Vehicles

VEHICLE	LOWEST SPEED (MPH)	DESIRABLE SPEED (MPH)	TRAVEL TIME DELAY (SECONDS)	IMPACT DISTANCE (FEET)
Fire Engine	21	25	0.8	136
	21	30	1.7	323
	21	35	3.0	505
	21	40	5.0	752
Aid/Medic	34	25	0.0	0
	34	30	0.0	0
	34	35	0.3	118
	34	40	1.5	263
Aerial Truck	16	25	1.8	254
	16	30	3.4	449
	16	35	5.9	674
	16	40	7.7	1039

Lowest Speed: This is the lowest speed a vehicle travels when crossing a 22-foot speed bump.
Desirable Speed: This is the speed a driver might wish to travel if there were no speed bumps.
Travel Time Delay: This is the additional time required to travel to a destination due to a 22-foot speed bump's influence.
Impact Distance: This is the length of street where a given vehicle cannot be driven at a given desirable speed because of the speed bump's influence.

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Typical Impacts of 14-Foot Speed Bumps on Emergency Vehicles

VEHICLE	LOWEST SPEED (MPH)	DESIRABLE SPEED (MPH)	TRAVEL TIME DELAY (SECONDS)	IMPACT DISTANCE (FEET)
Fire Engine	13	25	2.3	236
	13	30	3.7	399
	13	35	5.2	581
	13	40	7.7	814
Aid/Medic	17	25	1.0	147
	17	30	1.7	269
	17	35	2.9	483
	17	40	4.9	628
Aerial Truck	12	25	3.4	315
	12	30	4.9	485
	12	35	6.8	732
	12	40	9.1	1053

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